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Less partnering, less children, or both? Analysis of the drivers of first-birth decline in Finland since 2010?

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Abstract

In the 2010s, fertility has declined in the Nordic countries, most strikingly in Finland, and first births drive the decline. It remains unclear whether this decline results from decreased fertility within unions, changing union dynamics, or both. Thus, we investigated changes in the union–first birth dynamics from 2000 through 2018 in Finland using full-coverage population register data and an incidence-based multistate model. To do so, we calculated the yearly age-specific transition probabilities across states of single, cohabitation, marriage, and first births among 15- to 45-year-old childless men and women. We found lower fertility rates in unions after 2010, increasing dissolution rates amongst cohabiting couples, and long-term declines in the transition to marriage. Counterfactual simulations showed that, for the decline in first births since 2010, fertility within unions matters more (three-quarters) than union dynamics (one-quarter): that is, lower fertility in cohabitating and married individuals explained 42% and 13% of the decline, respectively, and decreasing fertility rates among couples entering cohabitation explained a further 17%. Decreasing marriage (19%) and cohabitation rates (2–4%) as well as higher union dissolution rates (6%) explained a smaller share of the first birth decline. The decline in first births was somewhat sharper among the lower social strata, but across strata the decreasing first birth transitions in unions explained most of the decline. To conclude, while changing union dynamics provide a partial explanation, postponing or foregoing fertility within unions represents the primary reason for the fertility decline.

Keywords: first births, union formation, union dissolution, Finland, incidence-based multistate model, counterfactual approach

Introduction

In the 2010s, fertility sharply declined in many parts of Europe, particularly in the Nordic countries. The steepest of these declines occurred in Finland, where the total fertility rate (TFR) fell from 1.87 in 2010 to an all-time low of 1.35 in 2019 (Fig. 1; Official Statistics of Finland (OSF) 2019; Human Fertility Database 2019). The Nordic fertility decline likely reflects declining lifetime fertility given that completed cohort fertility is projected to decline substantially for the first time in decades (Hellstrand et al. 2020). This projected decline is surprising, since the Nordic region previously featured a relatively high and stable cohort fertility, partly enabled by extensive social policy support provided by these countries intended to reconcile work and family life (McDonald 2000; Esping-Andersen 2009). Important findings identified first births as the main driver of the Nordic fertility decline (Hellstrand et al. 2020). In Finland, for instance, 75% of the decline is attributable to first births (Hellstrand, Nisén, and Myrskylä 2020). Therefore, a better understanding of why first births continue to decline should allow us to understand the general fertility decline.

Since most first births occur within unions (Kiernan 1999), changes in union formation and union stability represent important factors in explaining fertility changes (Hiilamo 2020). Finland and other Nordic countries serve as forerunners in shifting family formation patterns, such as lengthened single living during young adulthood, an increased progression to premarital cohabitation, and childbearing among cohabiting couples (Surkyn and Lesthaeghe 2004). The long-term increase in the share of the population living alone accelerated in more recent years in Finland. Specifically, in the 15- to 29-year-old age group, the share living alone rose from 21.0% in 2015 to 25.9% in 2019 among men and from 18.8% to 23.9% among women Fig. 1. Simultaneously,

the number of childless cohabiting couples at older reproductive ages continues to increase. However, it remains unclear how the transitions into and out of unions and from unions to first births have changed over time, and whether these changes vary based on socioeconomic status.

The recent fertility decline occurred after the onset of the Great Recession, yet recession indicators insufficiently explain the fertility decline (Comolli et al. 2020). The fundamental reasons for the fertility decline remain unknown, but are hypothesised as linked to broader uncertainty beyond the actual own circumstances (Vignoli, Guetto, et al. 2020) as well as to lifestyle factors (Rotkirch 2020). Important questions as yet unaddressed include whether and how the decline in first birth rates since 2010 relates to changes in unions. That is, first births may be decreasing due to increasing difficulties related to forming or maintaining unions, due to decreasing tendency to transition to parenthood among couples, or due to a combination of these factors. By analysing whether the decline is driven by changes in unions versus changes in fertility within unions, we can also indirectly evaluate the pertinence of the reasons hypothesised as driving the fertility decline. For example, a decline in first births primarily attributed to changes in fertility within unions would support the uncertainty theory, whereby couples use past experiences and shared narratives (from peers, social media, or others) according to or despite actual circumstances to make fertility decisions (Vignoli, Guetto, et al. 2020). Yet, uncertainty may not explain cohabitation patterns (Guetto, Vignoli, and Bazzani 2020). Alternatively, changes in unions and changes in fertility within unions would both agree with the second demographic transition (SDT) theory, which predicts ‘less family’ due to self-actualisation values.

Understanding trends related to socioeconomic status (SES) may shed more light on the fertility decline. Different SES groups may change their family behaviour for different reasons. Based on the SDT narrative, we would expect to observe a greater decrease in childbearing within unions and/or changing partnership dynamics among more highly educated individuals in favour of alternative lifestyles. This stems from SDT assumptions whereby new demographic behaviours are adopted first by the those more highly educated (Lesthaeghe and Surkyn 1988). In contrast, changes in family formation patterns more strongly driven by lower SES groups may reflect economic constraints, while similar developments across strata would support the uncertainty theory. To date, previous research indicates that first birth rates have declined across all education groups, albeit slightly faster among the least educated women in more recent years (Comolli et al. 2020). This observation already contradicts the SDT framework. Yet, these factors were not analysed separately by type of union or by changes in union patterns.

Therefore, this study aims to examine the extent to which the decline in first birth rates in Finland results from changes in transitions between union states (single, cohabitating, and married) and changes in first birth rates within these states. We were particularly interested in changes in union formation (the transition from single to cohabitating and from cohabitating to married), union dissolution (the transition from cohabitating or married to single), and first birth rates within unions (the transition from cohabitating or married to first birth). Our research questions were as follows:

1. How have union–first birth dynamics changed over time?
2. Is the decline in first births driven by lower fertility in unions or by changes in union patterns?

3. How do these changes vary by socioeconomic status?

To answer these questions, we estimated the age-structured transition probabilities (single, cohabiting, married, and first births) among both men and women using full-coverage Finnish population register data, and worked with the probabilities within the Markov or matrix framework. We used an incidence-based multistate model and a counterfactual approach to estimate the impact of changes in union and first birth transitions on declining first births in Finland from 2000 through 2018. By investigating union–first birth patterns for men and women at childbearing age, our study contributes to understanding the recent fertility decline in Finland. Because Finland is often viewed as a demographic forerunner (Andersson et al. 2009), trends here might provide insights into current fertility trends more broadly. Furthermore, the Finnish population registers are exceptional even within the Nordic context in that they include detailed, long-term information on nonmarital cohabitation.

[FIGURE 1 ABOUT HERE]

Background

First births and union dynamics: theoretical perspectives

Family demographic patterns have substantially changed in high-income countries in recent decades. Since the 1960s, fertility and marriage rates have decreased from high levels, divorce rates have increased from low levels, and nonmarital cohabitation and childbearing outside marriage have become widespread (Lesthaeghe 2010). Furthermore, childlessness is becoming increasingly important in shaping fertility developments in high-income countries (Miettinen et al. 2015; Kreyenfeld and

Konietzka 2017), although much of the variation across countries in total fertility depends on variation in second and higher-order births (Frejka 2008; Zeman et al. 2018). In addition to the increased availability of efficient contraception fuelling early fertility declines beginning in the 1960s (Goldin 2006), these changes have often been attributed to changes in gender roles and shifts in attitudes and norms. More recently, broader economic uncertainty was also put forth as playing a role in fertility declines.

Theories linking gender equality and fertility argue that below-replacement fertility has paralleled greater gender equality, but that further improvements in gender equality may hinder very low fertility levels (McDonald 2000, 2013). The shift from a negative to a positive relationship between female employment and fertility in recent decades (Brewster and Rindfuss 2000; Ahn and Mira 2002) gave rise to theories predicting a U-shaped trend in fertility levels over time (Myrskylä, Kohler, and Billari 2009; Myrskylä, Billari, and Kohler 2011; Esping-Andersen and Billari 2015). These developments appear rooted in structural conditions rather than in new values (Goldscheider, Bernhardt, and Lappegård 2015), such as increases in women's education and employment (Oppenheimer 1994; Ní Bhrolcháin and Beaujouan 2012). As long as traditional gender roles prevail within families, the increase in women's labour force participation will increase work–family conflicts among women, thereby depressing fertility. By contrast, when men's involvement in family increases, resulting in an equal sharing of domestic chores, women's work–family conflicts are expected to decrease while fertility should recover (Anderson and Kohler 2015). Furthermore, once gender egalitarianism becomes the norm within the family as well, not only will fertility recover, but union formation and union stability will also increase (Goldscheider, Bernhardt, and Lappegård 2015). However, this U-shaped prediction linking gender

equality and fertility is largely fuelled by a cross-sectional association, despite limited evidence existing for this U-shaped association from advanced societies over time (Kolk 2019). Although the gender revolution has to date prevented cohort fertility from decreasing to very low levels, it has not (yet) increased it (Frejka, Goldscheider, and Lappegård 2018). At present, cohort fertility in the Nordic countries is predicted to decline for the first time in decades, further challenging these predictions (Hellstrand et al. 2020). Since no signs of weakening gender equality and family policies have been observed in the recent decade, the Nordic fertility decline demands alternate explanations.

The second demographic transition (SDT) theory represents a central theory to explain family changes in recent decades. While theories linking gender equality and fertility predict a reversal toward 'more family', SDT predicts sustained low fertility and a continuously weakening role for the family. Special emphasis lies on emerging living arrangements beyond marriage and the disconnection between marriage and childbearing (Lesthaeghe 2014). According to SDT, changes to family formation patterns associate with shifts in attitudes and norms towards greater individual autonomy and self-actualisation (Surkyn and Lesthaeghe 2004). The central idea is that departing from institutional controls and authority paves the way for greater individual autonomy in decision-making, whereby the emergence of 'higher order needs' drives fertility decisions (Mills et al. 2011). Hence, the importance of marriage decreases, alongside the rearing of a child increasingly becoming a conscious choice taken to achieve greater personal self-fulfilment (Van De Kaa 1987). Childbearing can be viewed as a competing event against other life goals, with women more likely postponing childbearing if they associate rearing children with impeding their

individual autonomy (Liefbroer 2005). Additionally, greater emphasis is placed on the quality of relationships, consequently leading to the postponement of commitment and a greater number of separations. According to SDT, it is generally assumed that shifts in demographic behaviours are first adopted by the more highly educated who possess more advanced post-materialist values, which then spreads to the rest of society (Lesthaeghe and Surkyn 1988). It follows, then, that this framework for the current fertility decline is supported by changes initially observed among more highly educated groups.

Finally, economic constraints and economic uncertainty serve as important factors explaining trends in family formation. According to microeconomic theories, couples with greater socioeconomic resources at their disposal are more likely to have (more) children given the costs associated with childrearing, when such costs are not counterbalanced by higher opportunity costs (Becker 1993). In advanced societies, individuals tend to postpone childbearing during times of economic uncertainty and accelerate it during economic growth (Sobotka, Skirbekk, and Philipov 2011). Specifically, high rates of unemployment tend to decrease first births among men and women (Neels, Theunynck, and Wood 2013). Similar features are also observed in relation to union patterns (Mills and Blossfeld 2003). Changes driven by lower SES groups may imply obstacles to family formation due to economic hardship. Recent studies emphasised that recessions can carry long-lasting effects on childbearing even following macro-economic recovery, as observed in the Nordic countries during the 2010s. This highlights the need for a broader framework of perceived uncertainty to explain fertility changes (Comolli et al. 2020). Some hypothesise that uncertainty in people's lives has increased due to increased globalisation and new information

channels (Vignoli, Bazzani, et al. 2020). In the narrative framework, expectations and imaginings about the future that extend beyond actual economic and labour market indicators or current conditions may importantly influence fertility decision-making (Vignoli, Guetto, et al. 2020) and marriage intensions, while hardly any evidence exists to support the expectation that cohabitation formation is impacted by such uncertainties (Guetto, Vignoli, and Bazzani 2020). Unlike marriage and, particularly, unlike having a child, cohabitation is more easily reversible. This framework may be supported if the recent fertility decline is primarily explained by decreasing fertility and marriage intensities rather than by shifting cohabitation patterns, particularly if changes in demographic behaviour occur to a similar extent across all social strata.

First births and union dynamics: empirical observations

The observed patterns in family formation in recent decades support some theories while contesting others. The emergence of cohabitation began in forerunner Northern and Western European countries in the 1970s, and has in accordance with SDT subsequently spread to other countries (Lesthaeghe 2020). In 2011, the proportion of the population aged 20 and older cohabitating varied from 2.9% in Croatia to 18.3% in Sweden, with an average of nearly 9% across all European countries (Corselli-Nordblad and Gereoffy 2015). The vast majority of all first unions (over 75%) in most Northern and Central European countries begin as cohabiting unions (Perelli-Harris 2015). The expansion of cohabitation has associated with delays in marriage (Bumpass, Sweet, and Cherlin 1991) and declining marriage rates. The average crude marriage rate among 28 European countries decreased from 6.3 in 1990 to 4.4 per 1000 persons in 2016, while

the age at first marriage concurrently increased, such as in Finland, where it increased from 26.3 years old in 1990 to 31.7 years old in 2018 (Eurostat 2020).

The average share of births to unmarried women across 30 OECD countries has almost doubled in the last 20 years, from 23% in 1995 to 40% in 2016 (OECD 2019). Thus, as births become increasingly disconnected from marriage, children are increasingly born to cohabiting couples (Kennedy and Bumpass 2008; Thomson and Eriksson 2013). However, married couples still have stronger childbearing intentions (Miettinen and Rotkirch 2008) and higher first birth rates than cohabiting couples (Baizán, Aassve, and Billari 2004; Jalovaara and Miettinen 2013). For instance, the mean age at first birth is lower than the mean age at first marriage in many European countries, particularly in the Nordic countries, with the difference reaching a high of 4.7 years in Sweden in 2018 (Eurostat 2019, 2020). A study from Iceland confirms that the order of events accounts for this change: marriage now takes place after rather than before childbearing, although marriage does not seem to be declining (Jónsson 2020).

Moreover, divorce rates have been increasing for some time, although they began declining in most high-income countries in the early 2000s, notably aligning more with gender equality theories than SDT. The crude divorce rate reached a peak of 2.1 in the period 2005–2007 among the EU28 countries (Eurostat 2021). Cohabiting couples exhibited much higher separation rates than married couples throughout Europe (Liefbroer and Dourleijn 2006), although evidence from Finland indicates that most cohabiting couples that do not separate eventually marry (Jalovaara 2013).

Moreover, cohabitation has evolved quite similarly across all social strata in Europe, with individuals more highly educated leading this development in some regions and

the least educated in others (Lesthaeghe 2020). In the most gender egalitarian countries, better educated women are more likely to marry than lower educated women (Kalmijn 2013). In Finland, a higher degree of socioeconomic resources promote both cohabitating and marriage and associate with a lower risk of union dissolution, features remarkably similar for both men and women (Jalovaara 2012, 2013). In terms of childbearing among cohabiting couples, a consistent negative educational gradient exists, whereby the least educated are more likely to have children in cohabitating unions while the more highly educated tend to exhibit higher first birth rates within marriage (Perelli-Harris et al. 2010). This aligns more with the 'pattern of disadvantage', whereby lower SES groups face obstacles to marriage, rather than SDT predictions whereby more highly educated individuals are more prone to have their first birth outside marriage (Perelli-Harris and Gerber 2011).

Analyses of cohort parity progression ratios to first birth reveal a stable or only slightly declining trend among women born between 1940 and 1970 in Northern, Eastern, and Central Europe, but steeper declines in German-speaking countries, Southern Europe and East Asia (Zeman et al. 2018). Parity progression ratios to first birth vary from 0.91 in Eastern Europe to 0.78 in German-speaking countries among the youngest cohorts. The Nordic countries lie in the middle, although Finland consistently exhibits lower rates, more closely resembling levels from German-speaking countries (Sobotka 2017).

In Finland, difficulties encountered in finding a mate represent one likely factor explaining high rates of childlessness. Some have argued that gendered changes in educational attainment may affect fertility, both directly and indirectly through union formation and dissolution (Van Bavel 2012). The more recent gender imbalance in education, such that women have become better educated than men, limits the

opportunities of finding a suitable partner, since historically women have formed unions with men at least as well educated as themselves. This new gender imbalance in education is particularly pronounced in Finland, since men are twice as likely as women to have achieved only a basic or at most lower secondary level of education. Moreover, less than 40% of Finnish men have completed at least some level of tertiary education, an achievement more than 50% of Finnish women can claim (Jalovaara et al. 2019). A stable partnership is also a strong prerequisite to childbearing in Finland (Jalovaara and Fasang 2017). Along these lines, marriage serves as an indicator of greater union stability as opposed to cohabitation and proof of a commitment, and married men and women are least likely to remain childless (Saarela and Skirbekk 2019).

Ultimate childlessness has recently sharply increased among less educated men and women in all Nordic countries, and, consequently, the female educational gradient in childlessness has reversed (Jalovaara et al. 2019). Currently, both the least educated men and women are most likely to remain childless: in a late 1960s Finnish cohort consisting of individuals who completed only a basic education, over 30% of women and over 40% of men remained childless at age 40–41 (Rotkirch and Miettinen 2017). This negative relationship between educational attainment and ultimate childlessness among European men appears primarily driven by union histories (Trimarchi and Van Bavel 2017), applying to both men and women in Finland (Nisén et al. 2018; Saarela and Skirbekk 2019). Specifically, most Finns without children of their own have never lived in a stable, long-term cohabitating union (Jalovaara and Fasang 2017). Thus, the least educated men and women in Finland are more likely to remain childless primarily because they are less likely to form stable unions.

Moreover, events related to family formation patterns, such as moving out of the parental home, forming a union, and having the first birth, have been postponed to later ages for quite some time (Billari, Liefbroer, and Philipov 2006; Frejka and Sardon 2006). Individuals live increasingly longer in unions before they progress to parenthood, and often live in several different unions before a first birth (Wu and Schimmele 2005). In Finland, the age at first union has remained fairly stable over time, although first births have been postponed (Rotkirch et al. 2017). Postponing parenthood tends to associate with a number of factors, the most central of which is increasing education among women (Ní Bhrolcháin and Beaujouan 2012). On average, less educated individuals have children earlier than more highly educated individuals (Rendall et al. 2010). Furthermore, a positive relationship exists between first birth rates and female involvement in the labour market in Finland (Vikat 2004; Jalovaara and Miettinen 2013), while temporary jobs typical for young adulthood tend to delay entry into parenthood (Sutela 2012).

To summarise, cohabitation currently represents a natural first step in family formation, first births are increasingly more likely to coincide with cohabitation, and both childbearing and marriage are shifting to older ages. In Finland, a strong socioeconomic position promotes union formation, union stability, and childbearing among both men and women. Still, little is known about how fertility declines in the 2010s associated with changes in unions and whether these potential changes vary based on SES.

Data and methods

Data

In this study, we used Finnish national longitudinal population register data compiled at Statistics Finland (permission no. TK-52-1119-17). The register data were linked to different register sources such as information on childbirths, housing, educational attainment, and income through personal identification numbers, offering full coverage of the entire Finnish population. The study population consists of all childless men and women aged 15 to 45 years old permanently living in Finland on the last day of each year from 2000 through 2018. Individuals were followed until they had a first biological child or until they reached the age of 45. In total, the study population consists of 2 532 375 individuals and 23 847 070 person-years. Less than 0.06% of all first births were linked to two biological mothers/fathers. Consequently, the true parent for these children remained unknown. We excluded from our study 388 individuals linked to such a first birth.

For each individual, data include personal information on family status (single, cohabiting, or married) at the end of each calendar year. Statistics Finland defines cohabitation as a union of two unmarried adults of the opposite sex aged 18 or older who have been living in the same dwelling for at least three months, who are not siblings or differ in age by 16 or more years (Official Statistics of Finland (OSF) 2021). An individual is considered single if s/he is not living in a cohabiting or married union. Among the study population, 2.1% of men and 1.5% of women (446 787 observations) had missing information for family status (institutionalised population and/or otherwise unclassified), and were thus excluded from the study.

We formed yearly transitions for all individuals in the study population for whom personal information was available for two consecutive years. Information for two consecutive years was missing for all first entries into the study population (2 517 735 observations) and for individuals absent from the Finnish population during some period from 2000 through 2018 (130 467 observations). Furthermore, to avoid challenges related to incomplete educational data and an unknown number of unregistered first births to non-native Finns, we excluded individuals born abroad[1] (1 280 473 observations for 229 670 individuals). In total, we identified 19 468 815 yearly transitions between states (single, cohabitating, married, and first birth) for 2 125 172 individuals beginning in 2000. Among these, 740 537 were transitions to first births[2] and 2 911 543 were transitions between partnership states. Appendix Table A1 provides descriptive information about first births and partnership transitions in more detail.

We also estimated the transition probabilities based on SES. We considered four categories of educational attainment — primary, secondary, lower tertiary, and higher tertiary — and four income groups based on income quartiles stratified by age, year, and gender. Primary level includes those who completed at most a lower secondary level of education (ISCED 0–2), while secondary level refers to those who completed upper secondary and post-secondary non-tertiary levels of education (ISCED 3–4). Lower tertiary includes short-cycle tertiary education and a Bachelor's degree or the equivalent level (ISCED 5–6), while higher tertiary refers to those who completed a Master's

[1] Including individuals born abroad did not significantly change our primary findings.
[2] Paternal information is delayed in the registers, meaning that there are more missing fathers to children born towards the end of the study period. Around 2% of all first births born in 2000–2010 had no registered father, while the proportion rose to around 6% for first births born in 2018.

degree, doctoral degree or the equivalent level of education (ISCED 7–8). We used income as a complement to education to overcome the limitations related to using educational attainment as an explanatory variable in the period analysis — that is, currently, less educated groups include those who will later attain more advanced degrees. Because those enrolled in educational programmes in particular are known to exhibit lower birth risks (e.g. Kravdal 1994), we performed a sensitivity analysis which excluded students (shown in the appendix). Using both education and income also strengthens our analysis substantively, since educational attainment aligns more closely with the SDT framework, while income serves as a direct measure of the economic constraints.

Methods

We used a Markov chain multistate approach, which describes the transitions between a given set of states using transition probabilities (Briggs and Sculpher 1998). A Markov chain evolves in discrete time and moves step-by-step from state i to state j, with the property of being memoryless. That is, the probability of each transition depends only on the state attained in the previous step and not on the history of events (Kemeny and Snell 1971). The transition probabilities from state *i* to state *j* at a specific age and time are defined as

$$p_{ij}(age, t) = pr(State_t = j | State_{t-1} = i;\ age_{t-1}).$$

The step size in our analyses is one year.[3] Our state space includes the states of 'single', 'cohabitating', 'married', and 'first birth. An illustration of the state space and the

[3] When we refer to a specific year, we refer to the end of that specific year.

transitions between these states appears in Fig. 2. In our analysis, we distinguish between the transitions from 'single' to 'first birth and single' and 'first birth and union' in order to distinguish single parents from couples who begin cohabitating closer to the first birth event. The first birth event represents an absorbing state, meaning that once entered it cannot be left. All other states are nonabsorbing (transient) states. We estimated the yearly age-specific transition probabilities for each of the given set of states between the ages of 15 and 45 from 2000 through 2018 as

$$p_{ij}(x,t) = \frac{\#\text{individuals in state } j \text{ in year } t \text{ aged } x \text{ and in state } i \text{ in year } t-1}{\#\text{individuals aged } x \text{ in state } i \text{ in year } t-1}$$

using simple cross tabulations.[4] The probabilities were estimated separately for men and women, as well as for educational and income groups, respectively.

We used the estimated transition probabilities and counterfactual simulation to calculate what proportion of the decline in first births was attributable to changes in union dynamics versus the decline in fertility within unions. (For specific details, see the Technical appendix.) First, we calculated the age-specific first birth rates that would have been observed if the population in 2010 would have experienced the 2010 transition rates in the period from 2010 through 2018. We labelled this scenario 'constant probability births'. Using the age-specific first birth rates, we calculated the proportion ever having a first birth according to a life-table approach. Second, we calculated the age-specific first birth rate and the proportion ever having a first birth that we expect to have observed if the population in 2010 would have experienced the observed changes in transition rates in the period from 2010 through 2018. We labelled

[4] Fitting multinomial logistic regression models to the data would be an alternative, but the results would not differ.

this scenario ‘natural course births’. We decompose the difference between these two scenarios by changing the transition probabilities one at a time. For education groups, we adjusted the procedure to take into account that the study population progresses to higher education levels over time. Additional details appear in the Technical appendix.

[FIGURE 2 ABOUT HERE]

Results

Age-specific transition probabilities between states

First, we explored how the age-specific transition probabilities have changed over time. The selected yearly age-specific transition probabilities between single, cohabitating, and married individuals, and first births for childless men and women in Finland from 2000 through 2018 appear in Fig. 3. We show the developments for two selected age groups, 25 and 35, which represent the patterns among younger and older age groups, respectively. The age-specific transition probabilities for all events appear in Appendix Figure A 1.

Union formation

Since the early 2000s, the probability of forming unmarried, cohabitating unions has remained relatively stable across all ages. However, we observed a drop for the most recent years (2015–2018) among the younger ages, that is, at age 25 when the transition probability fell from 14% to 12% for men. Among women, a drop was observed only among those younger than 25. Thus, the yearly probability of remaining single has recently increased among younger individuals. The probability of marrying has exhibited a more long-term decline at nearly all ages. For instance, the yearly

probability of marrying at age 25 among cohabiting women has, since the early 2000s, decreased from 11% to 6% in 2018, peaking in 2008 at 8% for age 35, and then falling to 5% in 2018. Additionally, the low probability of shifting from single to married has decreased.

Union dissolution

Married couples exhibited a lower rate of union dissolution compared to cohabiting individuals at all ages. The rate of union dissolution among married couples remains similar across all age groups, remaining relatively stable over the period of interest. Among cohabiting couples, the rate of union dissolution was higher in the younger age groups. In recent years, the probability of a union dissolving among cohabiting men and women increased slightly at younger ages. That is, at age 25, the transition probability increased from 11% to 13% among women and from 14% to 15% among men from 2010 to 2018. Furthermore, the transition from marriage to cohabitation remains rare.

Transition to first births

The age pattern in the transition to first births differs widely for cohabiting and married couples. First birth rates within cohabitating couples were highest during the early 30s when around 10% of men and women who were cohabiting in 2017 experienced their first births in 2018. First birth rates among married men and women again peaked at very young ages. Thus, first birth rates were several times higher at younger ages among married versus cohabiting couples, a difference that persisted until the mid to late 30s. Since 2010, first birth rates have decreased among both cohabiting and married couples for nearly all ages, but more distinctly at younger ages. The decrease was, however, less pronounced among married women. For instance, from 2010 through 2018, the first birth rate at age 25 decreased from 0.27 to 0.21 among married women

and from 0.09 to 0.06 among cohabiting women. Furthermore, the low probability of transitioning from single to first birth—specifically the transition from single to first birth and entering a union—has decreased. We observed a sharp increase in the probability of remaining either as a cohabiting or a married couple without transitioning to a first birth.

[FIGURE 3 ABOUT HERE]

Transition probabilities by socioeconomic status (SES) groups

We further explored whether changes in partnering and first birth transitions were more pronounced in some SES groups than others, examining education (Fig. 4) and income (Appendix Figure A 2). We show the results for the lowest and highest SES groups.

The decrease in the transition to cohabitation observed at younger ages in the general population was visible primarily among less educated groups of women and men. We observed no change in cohabitation rates among women with tertiary-level education, but found a decline for the relatively small group of higher tertiary-level educated 25-year-old men. However, we observed a decline in cohabitation rates at age 25 and younger across all income groups. Furthermore, a long-term decreasing trend in the transition from cohabitation to marriage was observed across all SES groups, but appeared somewhat stronger among the more highly educated.

We also observed a slight increase in the transition from cohabitation to being single primarily among the least educated men and women, although a more similar increase was observed across income groups. Moreover, we observed no change in the transition from marriage to being single in any of the educational groups, except for a small

potential increase among the least educated at younger ages. No such pattern was observed for income groups.

Finally, we find that first birth rates have decreased both among cohabiting and married men and women across all SES groups. However, the decrease was less pronounced in the small group of married women in the lowest educational group.

[FIGURE 4 ABOUT HERE]

Contributions to declining first births, 2010–2018

Fig. 5 shows the contributions of the changes in first birth transitions, union formations, and union dissolutions to the decline in the number of first births from 2010 through 2018. We use the percentage experiencing a first birth, a synthetic age-standardised measurement indicating the proportion that expected to experience a first birth based on the observed rates. The observed changes in the transition probabilities led to a decline in the share experiencing a first birth to 68.1% for women and to 58.4% for men. This natural course scenario matches well with the true observed first birth rates (Appendix Figure A3). If the transition probabilities remained stable (i.e., as observed in 2010) across years, the share experiencing a first birth based on the age-specific first birth rates in 2018 would have reached 78.6% for women and 71.2% for men.

If first birth transitions (whether among single, cohabitating, or married individuals) had not decreased, 76% of the observed decline in the share experiencing a first birth among women would have been dampened. The largest contributions originated from cohabiting women (42%), followed by women who were single at the end of the year, but who experienced their first birth and lived in a union at the end of the following year (17%) and married women (13%). The decrease in single motherhood also

insubstantially contributed (4%). Furthermore, if union formation had remained stable, the decrease would have been dampened by 21%. Decreasing marriage rates appeared vastly more important (19%) than decreasing cohabitating rates (2%). In addition, the small increase in dissolution rates contributed modestly (6%). Among men, the results were largely similar, but, the decrease in cohabitation rates, for instance, was slightly more important among men than among women.

[FIGURE 5 ABOUT HERE]

Contribution by socioeconomic status groups

Fig. 6 and Appendix Figure A 4 show the contributions to the first birth decline based on education and income. The total decline was larger in the lower SES groups. Specifically, the share ever experiencing a first birth fell from 2010 through 2018 from 65% to 48% for women with primary education and from 82% to 75% for women with higher tertiary education. Similarly, the share ever experiencing a first birth in this same time period fell from 58% to 44% in the lowest income group and from 90% to 82% in the highest income group. In addition, we noted that the contribution associated with changes in first birth transitions versus changes in unions to the declining first birth rate is, in general, similar across all SES groups. However, some differences emerged. First, the decline in first birth transitions among married individuals explained a larger share of the total first birth decline among women with a higher level of education. That is, the share explained is almost four times higher among those with a tertiary-level education (27%) than among those who completed primary education alone (7%). This reflects both the fact that the first birth transition probabilities for married individuals

with primary level education declined less as well as the difference in the population composition: a much higher proportion of more highly educated individuals were married. In turn, the declining transition to single motherhood appeared more important for women with the least education. Turning to union formation, declining cohabitation rates appear more important among women with the least education. The contribution of changes in cohabitation rates negatively (although slightly) associated with a tertiary level of education among women, meaning that cohabitation rates have, in fact, increased among this group. If such rates remained unchanged, first birth rates would have decreased slightly faster. This also results from the low number of more highly educated individuals at ages coinciding with decreases in the cohabitation rates. Here, again, the results for men are, in general, rather similar, yet some differences exist. For instance, the declining cohabitation rates among the least educated were slightly more important among men. In addition, the contribution of decreasing single parenthood did not concentrate within any educational group as they did among women.

Finally, when we compare income groups among men and women in the lowest and the highest income groups, we find a pattern similar to (but not as strong as) that for educational groups. The declining cohabitation rates appear more important for the lower income group, the declining marriage rates appear more important for the higher income groups, and the importance of the declining first birth rates among married individuals increases with income group. However, the pattern is less clear among women in income quartile groups 2 and 3 (results not shown). For instance, the importance of declining cohabitation rates is notable for income quartile group 3, but not for group 2. The decreasing transition to first births among married individuals is also more important in income group 2 compared to group 3.

[FIGURE 6 ABOUT HERE]

Discussion

Here, we investigated how the fertility decline in the 2010s in Finland associated with changes in fertility in unions and with changes in union formation and dissolution. Using full-coverage Finnish register data, an incidence-based multistate model, and a counterfactual approach, we analysed the changes in the transition probabilities between relationship states among single, cohabitating, and married individuals, and in the transition to first birth among each relationship state in Finland from 2000 through 2018, and estimated the impact of these changes on the first birth decline in Finland during the 2010s. We observed a lower fertility in unions after 2010, a long-term decline in marriage rates, and increasing dissolution rates among cohabiting couples. Lower fertility in unions explained around three-quarters of the total decline in first births, and the decreasing first birth transitions appeared more important among cohabiting couples than among married individuals. Consequently, changes in unions explained around one-quarter of the total decline in first births. Furthermore, lower marriage rates were more important than changes in cohabitation formation and cohabitation dissolution, and increases in cohabitation dissolution were more important than declining figures in cohabitation formation in explaining the first birth decline. Results were similar for both men and women.

In agreement with a recent Nordic study (Comolli et al. 2020), the total decline in first births was stronger among less educated groups. Similarly, we found that first births declined more strongly in lower income groups. However, our findings were largely

consistent across SES groups, whereby first births declined in all groups and childbearing within unions explained most of this decline. Nevertheless, across educational groups, the decrease in the transition from cohabitation to marriage explained more of the decline among those most educated, while the decrease in the transition from single to cohabitation explained more of the decline among the least educated. Results remained relatively consistent regardless of whether education or income was used as an indicator of socioeconomic position. We note, however, that some differences between income groups were not as strong as those that emerged between educational groups. Moreover, the probability of experiencing a first birth while cohabitating declined rather consistently across SES groups. Yet, among married individuals, the decline remained weak among the least educated, potentially reflecting the selection of this small group.

The changes in family formation witnessed since the 1960s in the Nordic and other countries, such as postponing and declining fertility and the rise in alternative living arrangements compared to marriage, have often been explained by the second demographic transition theory (SDT), where the weakening of traditional family values gives rise to individual autonomy and self-actualisation (Lesthaeghe 2014). Contrary to the predictions of SDT, the recent new family demographic developments in Finland were not necessarily driven by more highly educated individuals. An exception is the (absolute) decrease occurring from 2010 through 2018 in the likelihood of entering into marriage among individuals cohabiting, which appeared slightly more pronounced among the higher SES groups. Yet, marriage rates continue to remain highest within these groups. Taken together, the role of shifting family-related values for the current first birth decline cannot be entirely rejected based on our results. However, the largely

consistent developments observed across SES groups call for alternate explanations in our view.

Increasing uncertainty has been suggested as a driver of the declining fertility trends in the Nordic (Comolli et al. 2020) and other European countries (Vignoli, Bazzani, et al. 2020). In addition to economic uncertainty, alongside uncertainty stemming from globalisation dynamics, new technologies, and media channels since the onset of the Great Recession may have increased within people's lives (Vignoli, Bazzani, et al. 2020). As planning for the future becomes increasingly difficult, some researchers hypothesise that individuals may act according to or despite this uncertainty (Vignoli, Guetto, et al. 2020). Therefore, fertility declines may not concentrate strongly in the lower SES groups, individuals who experience greater economic constraints, but observed more consistently across groups (Comolli et al. 2020). The recent patterns observed in Finland provide at least partial support for this theoretical perspective. First, the patterns generally remained consistent across SES groups, perhaps even more strongly among those with the least education or lowest incomes. Second, the declining fertility rates in unions explained the lion's share of the decline in first births. Thus, uncertainty may not represent an obstacle to forming a cohabiting union as it is for more permanent and irreversible life decision like childbearing or marriage (Guetto, Vignoli, and Bazzani 2020). The sharper decline among those with fewer socioeconomic resources, however, suggests that uncertainty is more likely experienced among those facing actual economic constraints.

Although the decrease in the transition to cohabitation did not strongly explain the total decline in first births, its role should not be dismissed. A declining trend towards entering a cohabiting union remained notable primarily among the lower SES groups.

Cohabitation rates have been stable in Finland for quite some time, but began declining at younger ages after 2015, a departure from the previous long-term trend. It is still unclear whether this merely reflects postponement or if we are also observing an increase in the share of individuals who never partner in the near future. The sharper decline in cohabitation rates among the lower SES groups, particularly among men, may imply that these groups are experiencing greater difficulties in the mating market. In our study, we were unable to capture possible changes in couple formation among couples not cohabitating, since such information is unavailable from various registers. We agree with previous views arguing that the increase in the availability of dating partners through online dating sites and its effect on (un)stable union formation requires further investigation (Hiilamo 2020).

First births in contemporary Finland are typically born to cohabiting couples, whereby marriage follows childbearing. In this current trend, however, the declining marriage rates since 2010 are not followed by increasing nonmarital births, given that decreases in first births among cohabiting couples represent the primary driver of declines in total first births. Instead, the tendency to remain cohabiting without transitioning to either marriage or the first birth has increased rapidly, accompanied by a slight increase in the risk of separation among younger cohabiting couples. We observed a slower decline in the first birth transition among married couples compared to cohabiting couples. This trend was expected, since marriage reflects a stronger commitment and promotes childbearing more strongly than cohabitation (Miettinen and Rotkirch 2008; Jalovaara and Miettinen 2013) and rates of ultimate childlessness are low among married couples (Saarela and Skirbekk 2019). It may be that childbearing intentions have declined among cohabiting and married couples in Finland. According to the Family Barometer

Survey of Finland, the share of individuals who regard no children as their ideal number of children has risen during the 2010s, from below 6% to over 20% among Finns in their early 20s (Berg 2018). It also seems plausible that weaker childbearing intentions may have contributed to declining rates of union formation. The partner's childbearing plans (Iacovou and Tavares 2011) together with changes in partnership status (Liefbroer 2009) represent important influences on fertility intentions.

If future transition probabilities remain at current levels and no catching up occurs, an inevitable consequence of the current first birth decline will result in increasing levels of ultimate childlessness. The expected proportion of childless individuals in Finland based on the first birth rates in 2010 and 2018, respectively, increased from 21.0% to 31.5% among women and from 28.7% to 41.5% among men. Given the sharp decline in childbearing within unions, future ultimate childlessness may relate less to the absence of unions. Previously, ultimate childlessness in Finland has been linked to never partnering and to short or unstable spells of cohabitation (Jalovaara and Fasang 2017). Furthermore, the negative educational gradient in ultimate childlessness has already widened among men in recent years, and the positive gradient is shifting towards a negative association among women (Rotkirch and Miettinen 2017; Jalovaara et al. 2019). Our findings suggest that all educational groups may witness increases in the rates of ultimate childlessness due to a declining progression to first births within unions alongside greater union instability, more greatly hindering childbearing among those least educated.

The primary strength of this study lies in our use of full-population Finnish register data, which distinguished nonmarital cohabitation from marriage. National agencies typically report marriage indicators and births only within or outside marriage, which is

insufficient for understanding family-specific demographic changes within a context where cohabitation typically represents the first step in the family formation process and where first births concentrates within cohabitating unions. A further strength lies in our analyses of data for both men and women, since analyses on men's fertility remain rare. We also acknowledge several limitations in studying family formation based on educational attainment in the current period perspective, where the share enrolled (and in the decomposition analysis also the age structure) varies between groups with varying levels of attainment. Our sensitivity analysis (Appendix Figure A 5) revealed that the primary results regarding changes over time were quite similar regardless of whether we included currently enrolled or not. We note, however, that we must wait until the younger cohorts reach their final level of education to fully understand more recent patterns based on education. Reassuringly, the analysis by income group also indicated largely similar socioeconomic patterns in recent declines as those found from our analysis based on education.

To the best of our knowledge, no studies have used this same methodological approach to study changes in unions versus changes in fertility within unions. Similar methods have been applied in few prior studies. For instance, hazard ratios were implemented in microsimulation models to link fertility to marital behaviours in Canada (Bélanger, Jean-Dominique, and Spielauer 2010). In addition, a counterfactual approach was employed to examine the impact of union dissolution on fertility in Uruguay (Fernández Soto and Laplante 2020). Our model utilises annual transitions, given that it represents a straightforward way of proceeding and because the socioeconomic data are available at the end of each calendar year. Potentially, using shorter transition periods for cohabitation, such as every three months, might prove appropriate, since that is the

minimum time within which to capture unions in the registers. But, such short transitions may not be more informative vis-à-vis first birth transitions. An important question arises regarding whether we missed short-term changes in our approach. For instance, it is technically possible to observe a decline in the annual transition to cohabitation simply if the formation of cohabiting unions lasting shorter than one year increases while the number of total new cohabitating union formations remains constant. However, additional analyses revealed that the formation of unions lasting shorter than one year has also decreased in recent years (results not shown). In addition, our model did not take into account the duration of unions (Jalovaara and Kulu 2018). That said, additional analyses revealed that first births have decreased similarly regardless of union length, while separation rates increased both among shorter- and longer-lasting cohabiting unions, but not among very long-lasting (4+ years) unions (results not shown).

In conclusion, this study demonstrated that the sharp decline in first birth rates in the 2010s in Finland associated with changes in partnering. However, the declining tendency to experience a first birth within unions is most important in explaining the fertility decline. Future studies should specifically focus on the declining tendency to transition to parenthood among cohabiting couples, as well as to the increasing instability of such unions.

Online Appendices (Electronic Supplementary Material)

Technical appendix

The age-specific transition probabilities in a specific year from 2010 through 2018 were collected in the following 93 x 93 dimension transition matrix:

$$\widetilde{\boldsymbol{M}} = \begin{pmatrix} \boldsymbol{p}_{single\_single} & \boldsymbol{p}_{cohabitation\_single} & \boldsymbol{p}_{marriage\_single} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \boldsymbol{p}_{single\_cohabitation} & \boldsymbol{p}_{cohabitation\_cohabitation} & \boldsymbol{p}_{marriage\_cohabitation} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \boldsymbol{p}_{single\_marriage} & \boldsymbol{p}_{cohabitation\_marriage} & \boldsymbol{p}_{marriage\_marriage} & \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \mathbf{0} & \boldsymbol{p}_{cohabitation\_first\_birth} & \boldsymbol{p}_{marriage\_first\_birth} & \mathbf{1} & \mathbf{0} & \mathbf{0} \\ \boldsymbol{p}_{single\_single\_first\_birth} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{1} & \mathbf{0} \\ \boldsymbol{p}_{single\_union\_first\_birth} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{1} \end{pmatrix},$$

where $\boldsymbol{p}_{single\_single}$, $\boldsymbol{p}_{single\_cohabitation}$, $\boldsymbol{p}_{single\_marriage}$, $\boldsymbol{p}_{cohabitation\_single}$, $\boldsymbol{p}_{cohabitation\_cohabitation}$, $\boldsymbol{p}_{cohabitation\_marriage}$, $\boldsymbol{p}_{marriage\_single}$, $\boldsymbol{p}_{marriage\_cohabitation}$, and $\boldsymbol{p}_{marriage\_marriage}$ are 30 x 30 matrix blocks with non-zero elements only on the first subdiagonal. The 30 x 30 matrix blocks contain the age-specific transition probabilities between single, cohabitating, and married individuals at ages 15 through 44. For instance, the element in column one and row two of p_{ss} refers to the probability of remaining single between the ages of 15 and 16. Furthermore, $\boldsymbol{p}_{single\_single\_first\_birth}$, $\boldsymbol{p}_{single\_union\_first\_birth}$, $\boldsymbol{p}_{cohabitation\_first\_birth}$, and $\boldsymbol{p}_{marriage\_first\_birth}$ are 1 x 30 row vectors.

Finally, we decompose the decline in first births from 2010 through 2018 by transition probability using the first birth transition probabilities and the 90 x 90 submatrix $\boldsymbol{M}$, which contains only the following transient states:

$$\boldsymbol{M} = \begin{pmatrix} \boldsymbol{p_{single\_single}} & \boldsymbol{p_{cohabitation\_single}} & \boldsymbol{p_{marriage\_single}} \\ \boldsymbol{p_{single\_cohabitation}} & \boldsymbol{p_{cohabitation\_cohabitation}} & \boldsymbol{p_{marriage\_cohabitation}} \\ \boldsymbol{p_{single\_marriage}} & \boldsymbol{p_{cohabitation\_marriage}} & \boldsymbol{p_{marriage\_marriage}} \end{pmatrix}.$$

This is achieved by arranging the population in 2010 as the $90\ x\ 1$ matrix $\boldsymbol{N}$

$$\boldsymbol{N} = \begin{pmatrix} \boldsymbol{n_{single}} \\ \boldsymbol{n_{cohabitation}} \\ \boldsymbol{n_{marriage}} \end{pmatrix},$$

where, $\boldsymbol{n_{single}}$ is a $30\ x\ 1$ matrix with the number of single individuals aged 15 to 44, $\boldsymbol{n_{cohabitation}}$ is a $30\ x\ 1$ matrix with the number of cohabiting individuals aged 15 to 44, and $\boldsymbol{n_{marriage}}$ is a $30\ x\ 1$ matrix with the number of married individuals aged 15 to 44. In the constant probability births scenario, we transformed the population in 2010 using $\boldsymbol{N_{y+1} = M_{2010} N_y}$, where $y \in (2011, \ldots, 2018)$. The age-specific first birth rates are calculated as

$$\boldsymbol{ASFB} = (\boldsymbol{n_{single} p_{single\_single\_first\_birth}} + \boldsymbol{n_{single} p_{single\_union\_first\_birth}} + \boldsymbol{n_{cohabitation} p_{cohabitation\_first\_birth}} + \boldsymbol{n_{marriage} p_{marriage\_first\_birth}}) / (\boldsymbol{n_{single}} + \boldsymbol{n_{cohabitation}} + \boldsymbol{n_{marriage}}).$$

At each step, the population ages. Thus, when individuals are aged 15 to 44 in year t, they will be aged 16 to 44 in year t + 1 (45-year-olds are automatically dropped from the sample). Therefore, in year t + 1, we add to the population the number of 15-year-old individuals, all of whom are considered single. Based on the age-specific first birth rates in each year, we calculate the annual proportion ever having a first birth for a synthetic cohort of women following a life-table approach. In the natural course births scenario, we proceed similarly, but transform the population using $\boldsymbol{N_{y+1} = P_y N_y}$.

We decompose the difference between constant probability births and natural course births step-by-step by keeping one of the transition probabilities at the 2010 level, while allowing the remainder of the transition probabilities to change according to the natural course. In order for the probabilities from an initial state to sum up to 1, we adjust the transition probability remaining in that initial state as follows:

For the first birth transitions:

1. $\boldsymbol{p_{marriage\_marriage,y} = 1 - p_{marriage\_first\_birth,2010} - p_{marriage\_single,y} - p_{marriage\_cohabitation,y};}$
2. $\boldsymbol{p_{cohabitation\_cohabitation,y} = 1 - p_{cohabitation\_first\_birth,2010} - p_{cohabitation\_single,y} - p_{cohabitation\_marriage,y};}$
3. $\boldsymbol{p_{single\_single,y} = 1 - p_{single\_union\_first\_birth,2010} - p_{single\_single\_first\_birth,y} - p_{single\_cohabitation,y} - p_{single\_marriage,y};}$
4. $\boldsymbol{p_{single\_single,y} = 1 - p_{single\_union\_first\_birth,2010} - p_{single\_single\_first\_birth,2010} - p_{single\_cohabitation,y} - p_{single\_marriage,y}.}$

For union formation:

1. $\boldsymbol{p_{single\_single,y} = 1 - p_{single\_cohabitation,2010} - p_{single\_marriage,y} - p_{single\_union\_first\_birth,y} - p_{single\_single\_first\_birth,y};}$
2. $\boldsymbol{p_{single\_single,y} = 1 - p_{single\_cohabitation,2010} - p_{single\_marriage,2010} - p_{single\_union\_first\_birth,y} - p_{single\_single\_first\_birth,y};}$
3. $\boldsymbol{p_{cohabitation\_cohabitation,y} = 1 - p_{cohabitation\_marriage,2010} - p_{cohabitation\_single,y} - p_{cohabitation\_first\_birth,y}.}$

For union dissolution:

1. $p_{cohabitation\_cohabitation,y} = 1 - p_{cohabitation\_single,2010} - p_{cohabitation\_marriage,y} - p_{cohabitation\_first\_birth,y}$;
2. $p_{marriage\_marriage,y} = 1 - p_{marriage\_single,2009} - p_{marriage\_cohabitation,2010} - p_{marriage\_first\_birth,y}$.

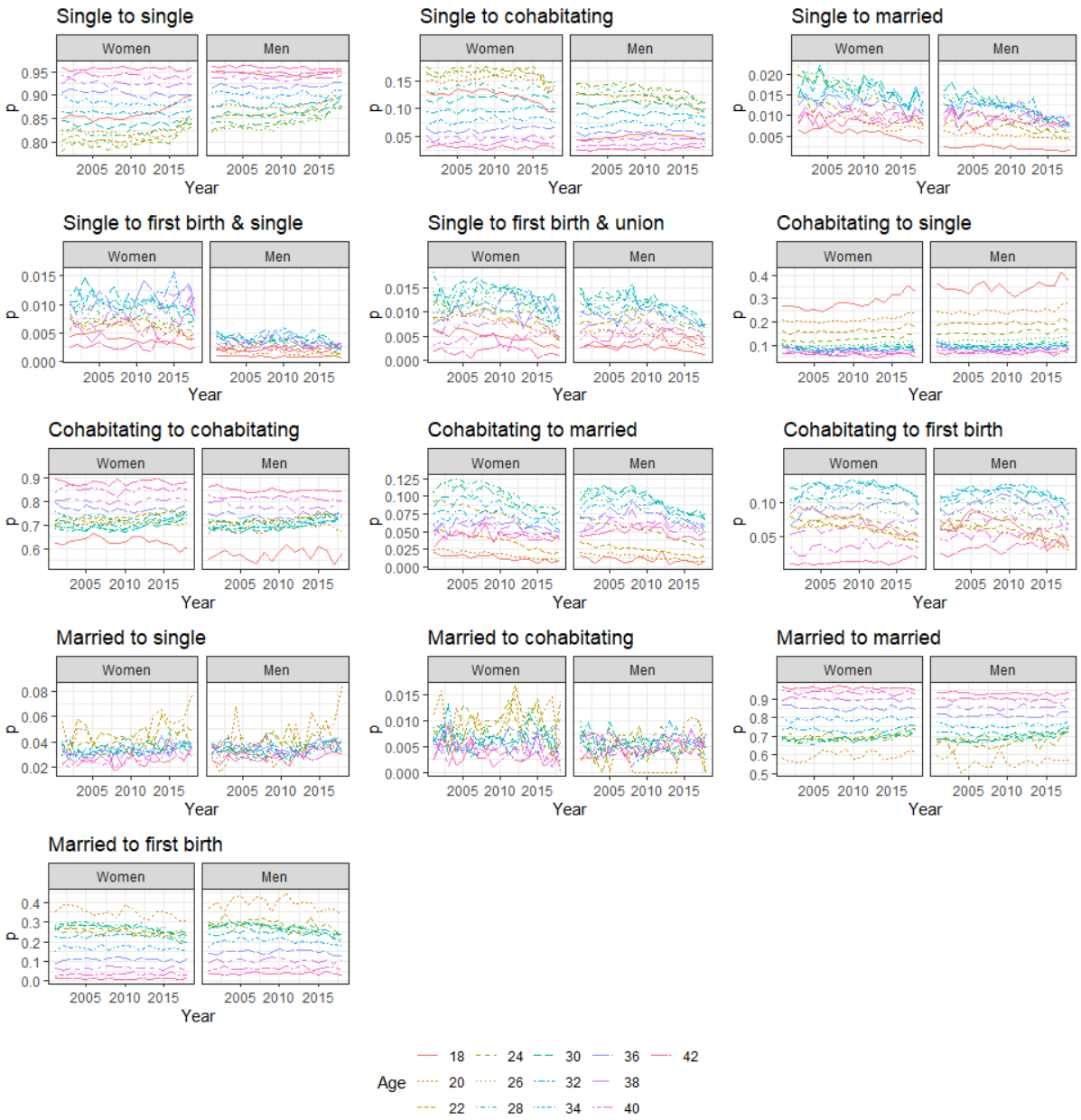
In the analysis of income groups, we proceeded similarly as we did for the total population. However, we considered 17 as the minimum age, since the majority of individuals had no or low incomes at younger ages. As the population ages, we add to the population the number of 17-year-old individuals in that income group.

For the educational groups, we proceeded as follows. We calculated the proportion moving to a higher education level in each year. When we transformed the population in the counterfactual approach, we removed the individuals moving to a higher education level based on the calculated rates. For those with a primary education, each year we add to the population the number of 15-year-old individuals; but, among the higher education groups, in year t + 1, we add the number of individuals with a lower education in year t at all ages and for all partnership statuses. For instance, those individuals with a primary education in year t but secondary education in t + 1 were added to the population of individuals with a secondary education in year t + 1. Similarly, in the sensitivity analysis excluding students, we removed the proportion beginning their studies, and added to the population those who graduated. Furthermore, we considered secondary education from age 18, lower tertiary education from age 22, and higher tertiary education from age 24 to avoid unstable rates.

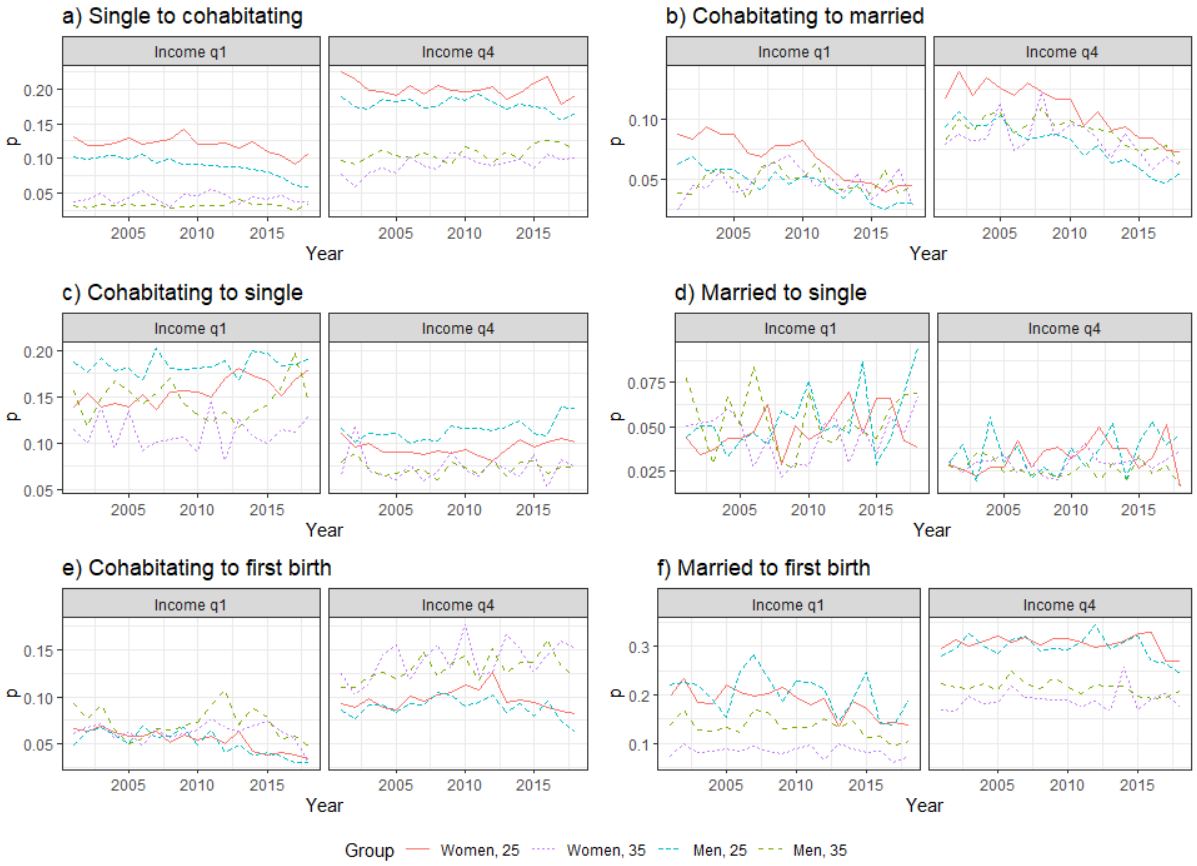
Appendix tables and figures

Appendix Table A1 Number of first births, person-years of exposures, and partnership status transitions among the childless population, ages 15 to 44 among women and men, 2000–2018

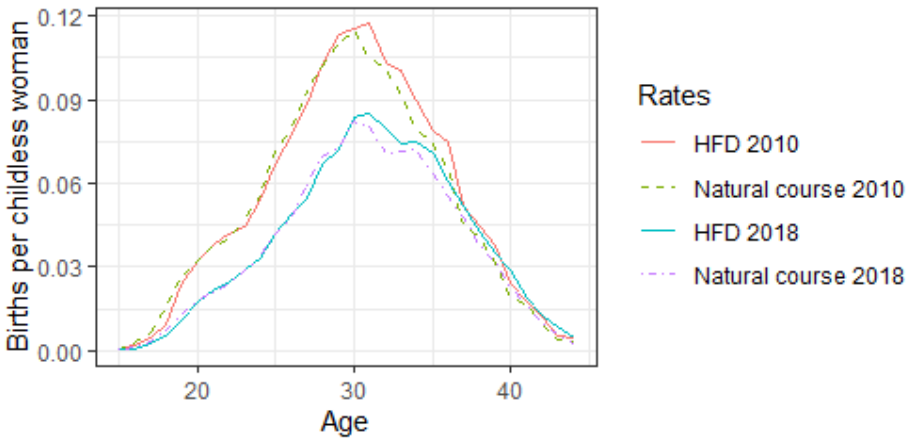
Characteristic	All (n = 2 125 172)	Women (n = 993 024)	Men (n = 1 132 148)
First births, number	740 537	379 051	361 486
Person-years of follow-up	19 468 815	8 806 785	10 662 030
Partnership transitions, number			
Single to single	12 419 504	5 232 453	7 187 051
Single to cohabitating	1 206 555	604 671	601 884
Single to married	102 370	51 424	50 946
Single to first birth & single	47 249	31 398	15 851
Single to first birth & union	86 883	40 965	45 918
Cohabitating to single	536 569	268 414	268 155
Cohabitating to cohabitating	3 018 824	1 532 222	1 486 602
Cohabitating to married	269 197	136 150	133 047
Cohabitating to first birth	334 546	168 932	165 614
Married to single	47 898	24 330	23 568
Married to cohabitating	8 417	4 670	3 747
Married to married	1 118 944	573 400	545 544
Married to first birth	271 859	137 756	134 103



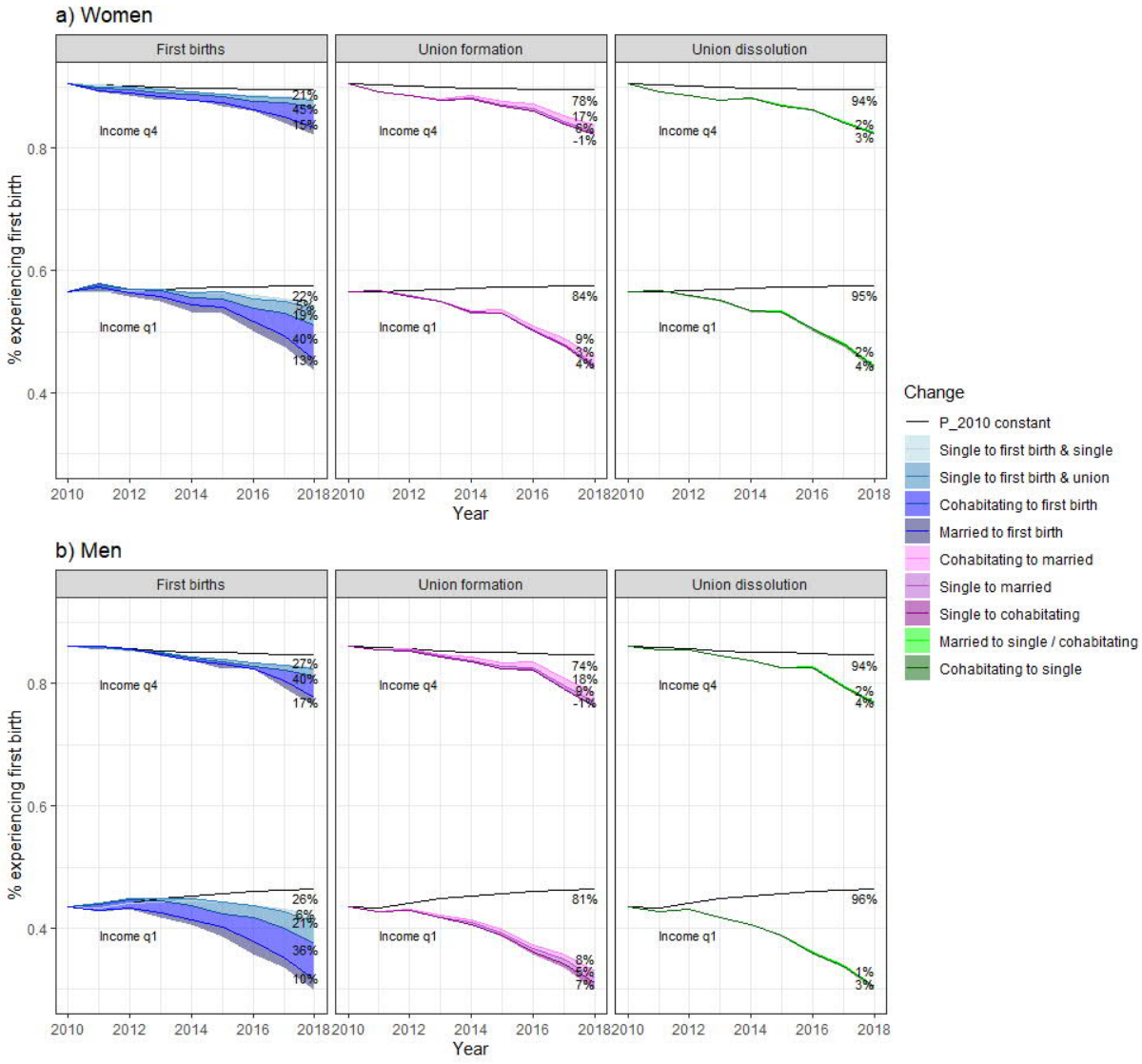
Appendix Figure A 1 Age-specific transition probabilities for single, cohabitating, and married individuals, and the first birth among childless women and men in Finland, 2001–2018



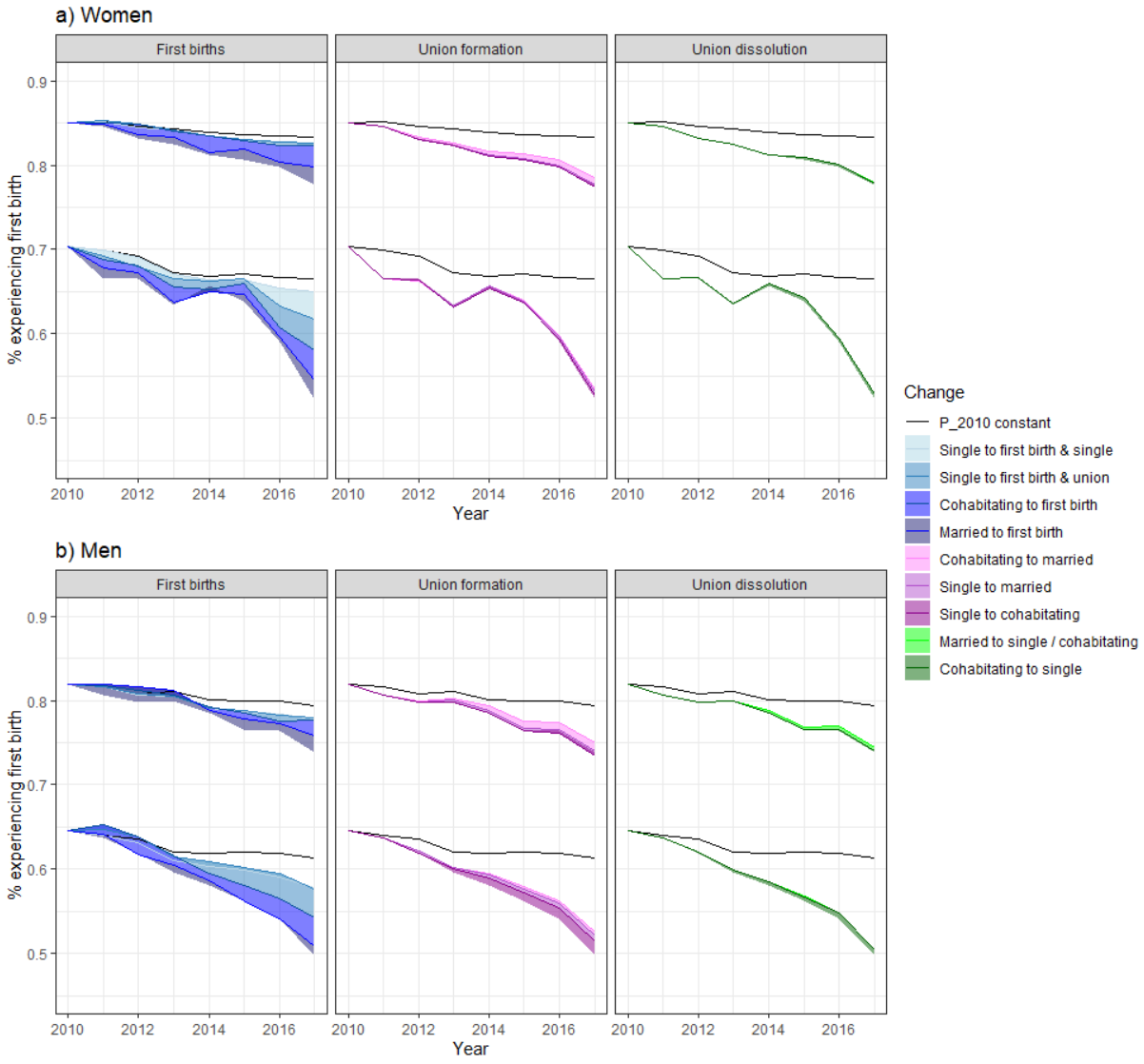
Appendix Figure A 2 Transition probabilities for single, cohabitating, and married individuals, and first births among childless women and men in 2001–2018 by income quartile group at ages 25 and 35



Appendix Figure A3 First birth rates (births per childless woman) based on the Human Fertility Database (HFD) and the natural course in 2010 and 2018



Appendix Figure A 4 Contributions of declining first births, changes in union formations, and changes in union dissolutions to the decline in the percentage experiencing first births based on the first birth rates in 2010–2018 by income quartile groups. The top curve shows the results for the highest income group, while the bottom curve shows the results for the lowest income group.



Appendix Figure A 5 Contributions of declining first births, changes in union formations, and changes in union dissolutions to the decline in the percentage experiencing first births based on the first birth rates in 2010–2017 by education groups, excluding students. (Information regarding education enrolment was incomplete in 2018). The top curve shows the results for the most educated, whilst the bottom curve shows the results for the least educated.

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FIGURES

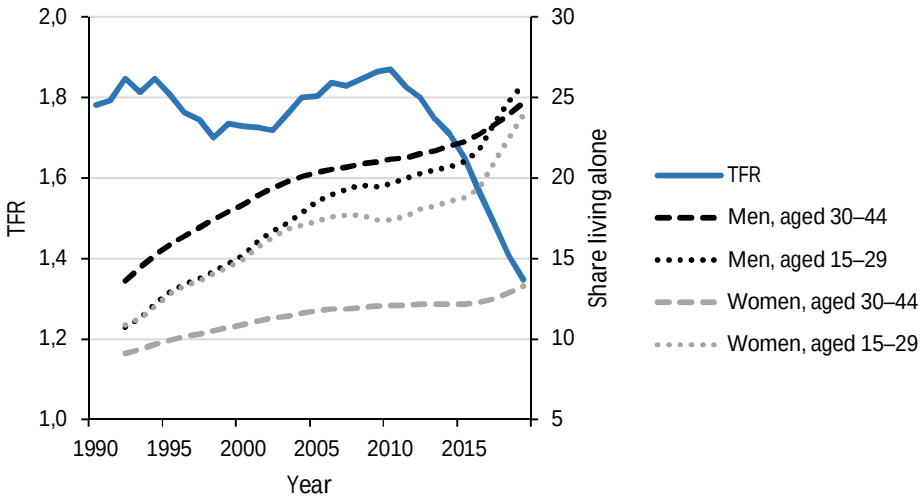

Fig. 1 The total fertility rate (TFR) and the share living alone by age group and gender in Finland, 1990–2019. Source: Statistics Finland 2020, authors' own calculations

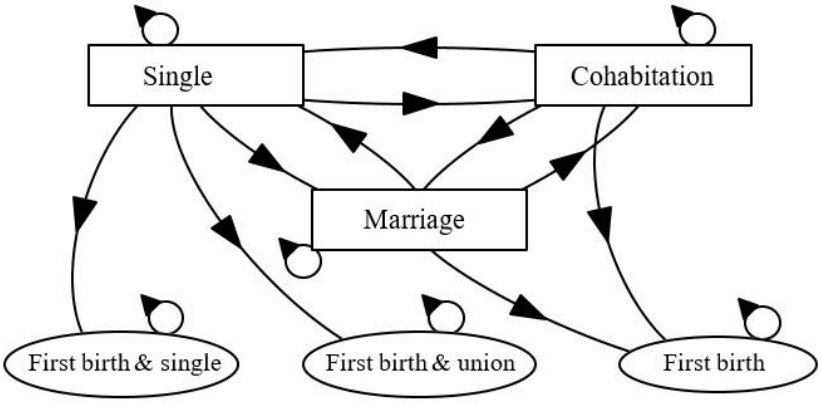

Fig. 2 State transition diagram for the Markov chain

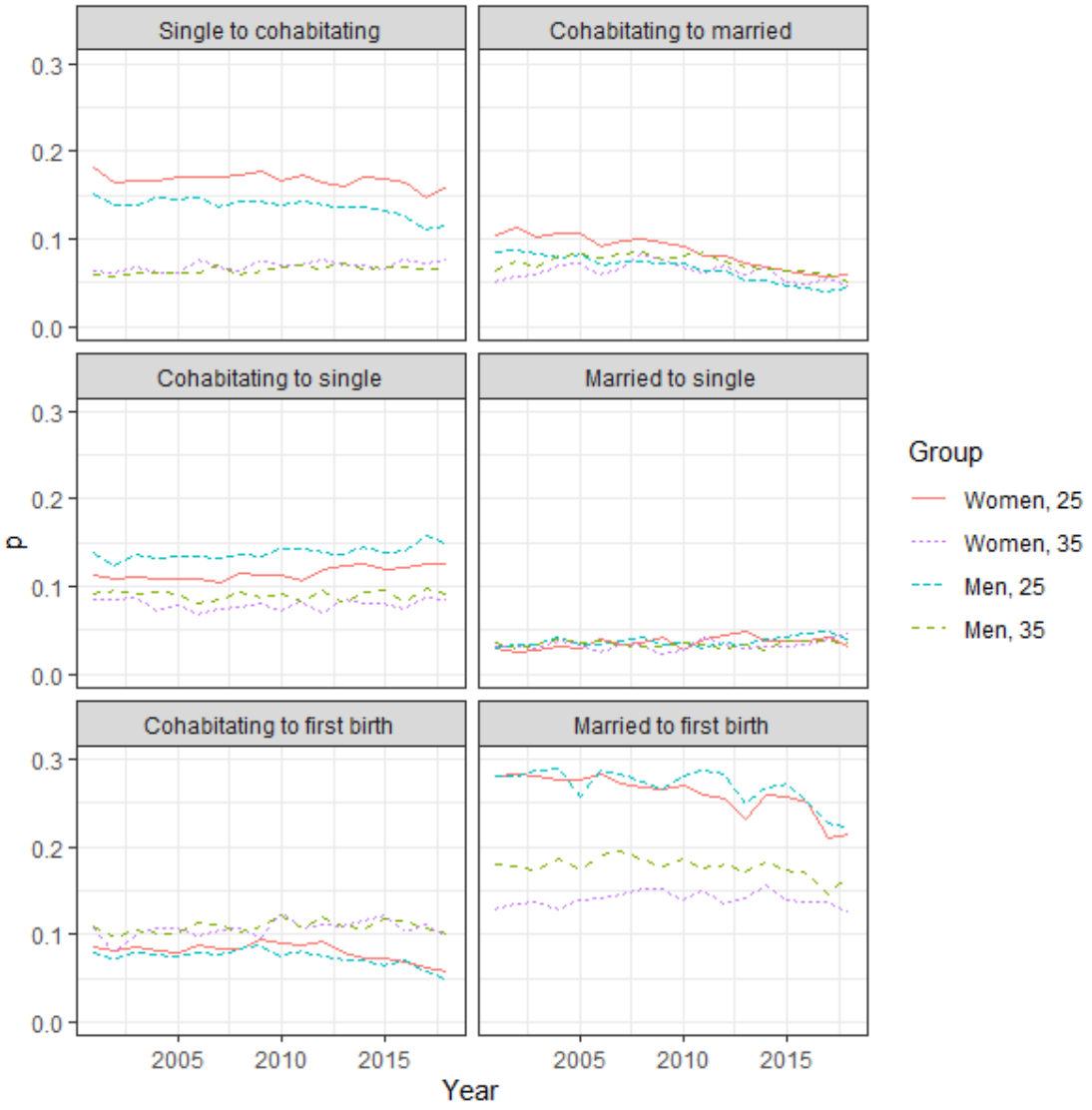

Fig. 3 Transition probabilities for single, cohabitating, and married individuals, and the first birth for childless women and men aged 25 and 35 in Finland, 2001–2018

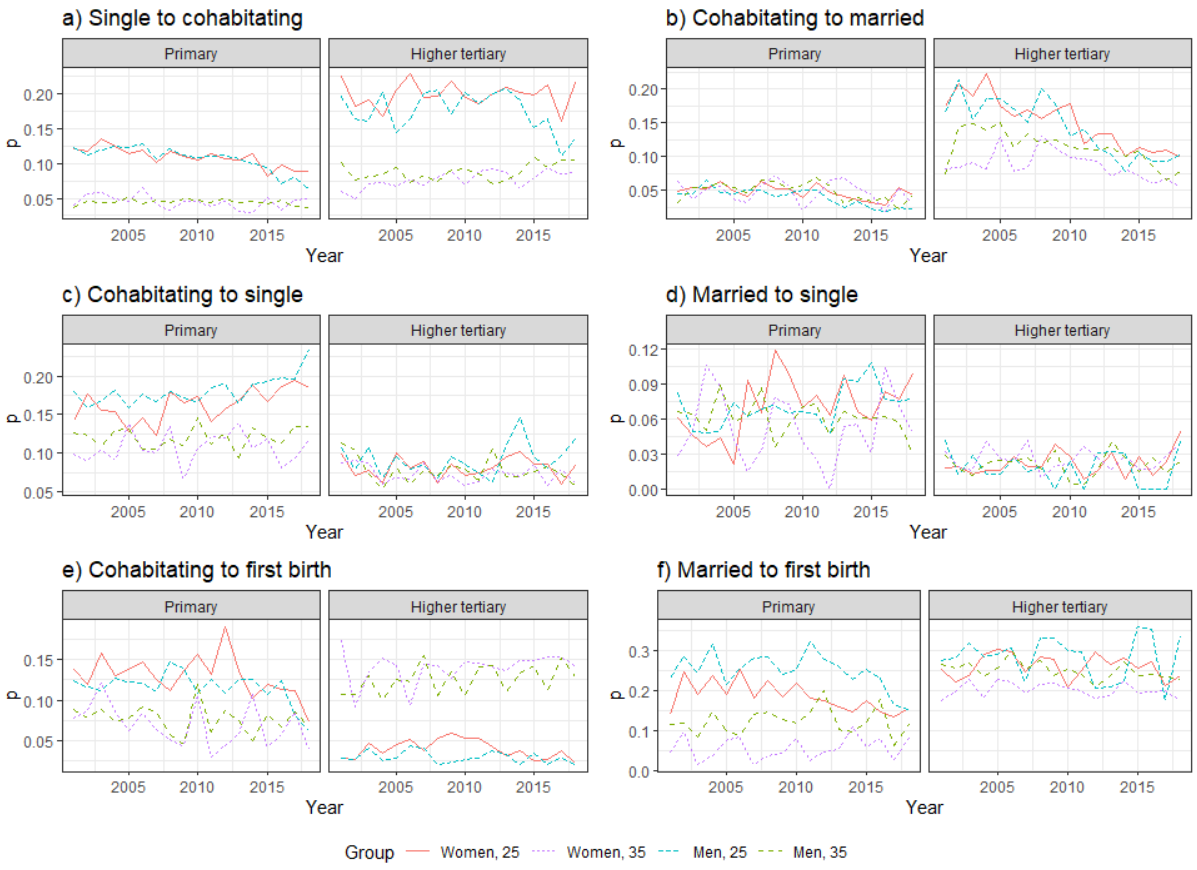

Fig. 4 Transition probabilities for single, cohabitating, and married individuals, and for first births among childless women and men in 2001–2018 by level of education at ages 25 and 35

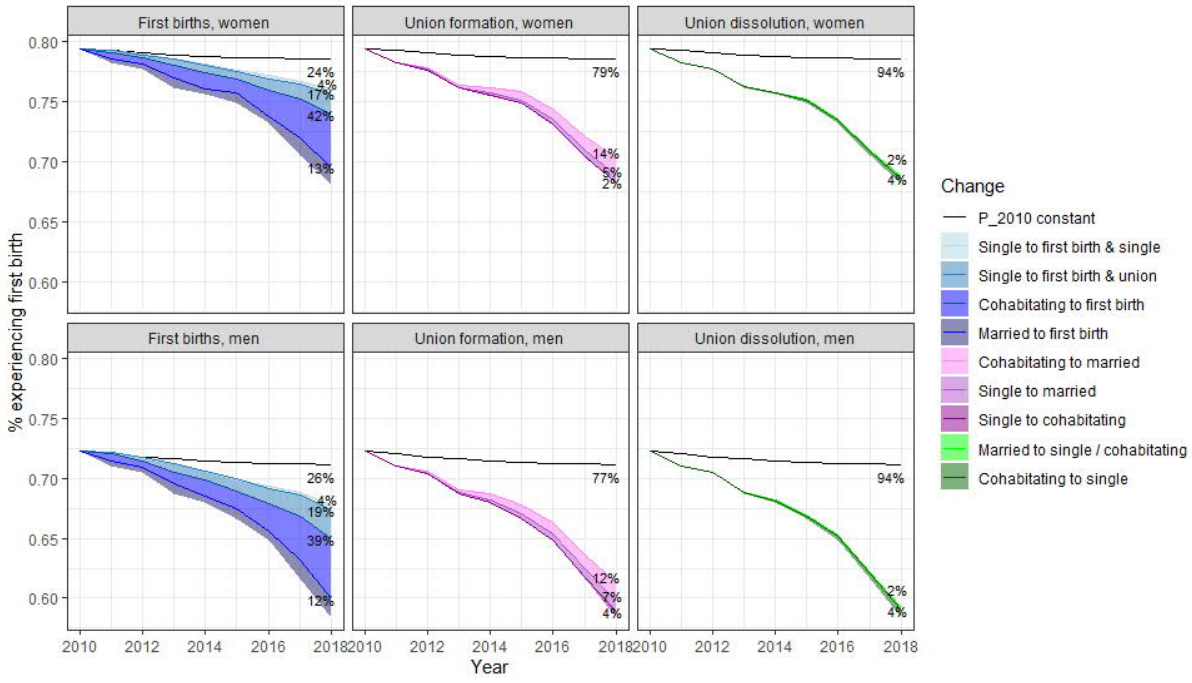

Fig. 5 Contributions of declining first births, changes in union formations, and changes in union dissolutions to the decline in the percentage experiencing first births based on the first birth rates in 2010–2018. The black solid line indicates the percentage experiencing a first birth that would have been observed if the population in 2010 would have experienced the 2010 transition rates in the years 2010 through 2018. Shaded areas indicate how much the decline in first births would have been dampened if the corresponding transition probabilities would not have changed.

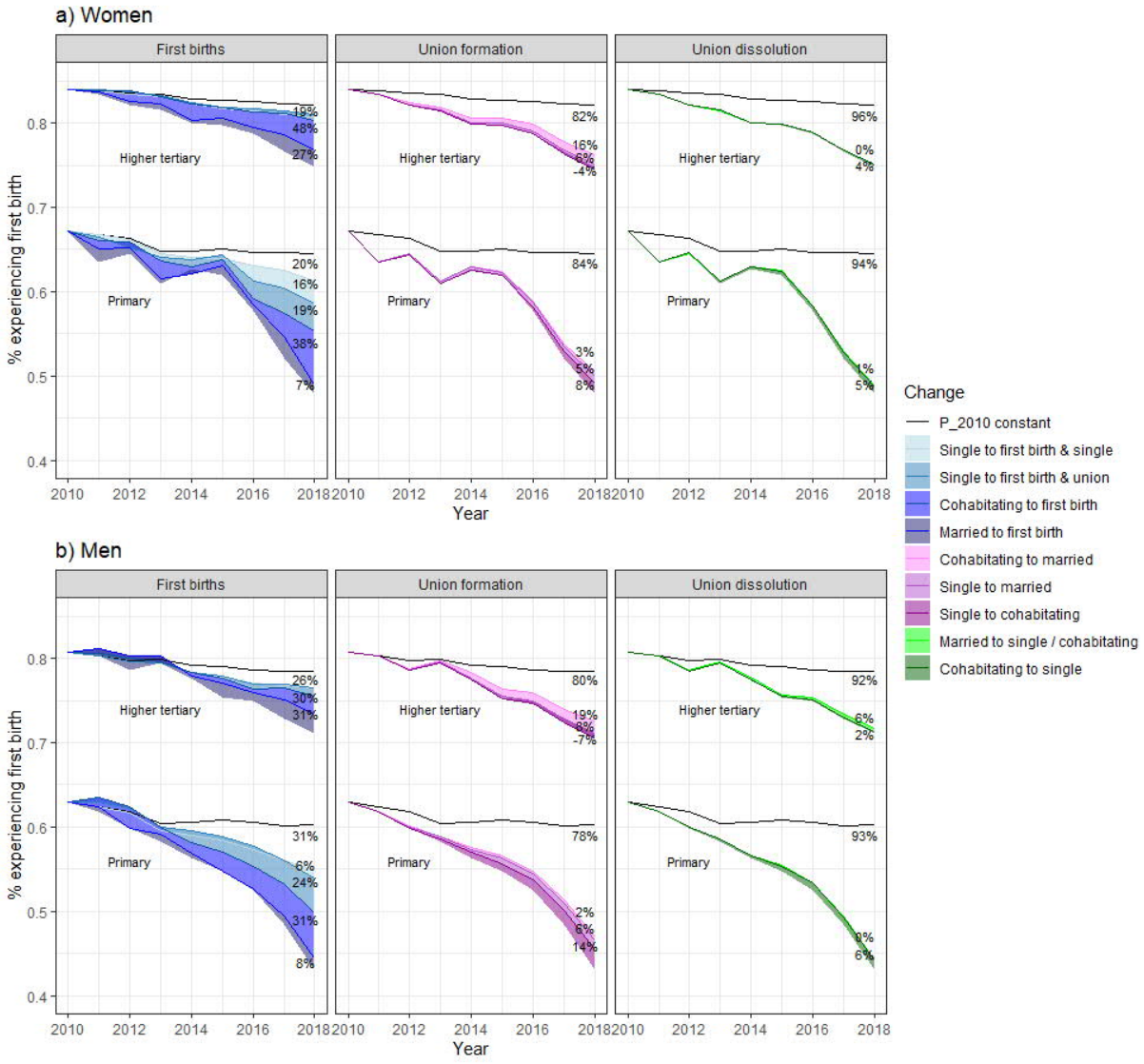

Fig. 6 Contributions of declining first births, changes in union formations, and changes in union dissolutions to the decline in the percentage experiencing first births based on the first birth rates in 2010–2018 by education groups. The top curve shows the results for the higher tertiary education groups, while the bottom curve shows the results for the primary-level education groups.